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AN UNUSUAL VERTICAL TEMPERATURE DISTRIBUTION OVER BRUSSELS AND PARIS

BY C. K. M. DOUGLAS, B.A.

The radio-sonde ascents at Brussels at 0300 G.M.T. on February 20, 1948, and at Paris (Trappes) at 1400 on the same day (Fig. 1) revealed an atmospheric structure which is probably almost unique in western Europe. At Brussels the temperature at 650 mb., slightly below the inversion, was 39°F. below the February normal, but at 450 mb. it was only 16°F. below normal. (These figures are based on the 23-yr. average for February in East Anglia. The mean isotherms in winter are orientated roughly north-west to south-east, so that the Brussels normals cannot be appreciably different.) At Paris the lower layers were only slightly less cold, though there was a peculiar inversion at 900 mb. The Paris tropopause was at the astonishing level of 580 mb. (13,520 ft.). At Brussels the tropopause was at 450 mb. (19,500 ft.) but the lapse rate from 550 to 450 mb. was only 2.8°C./Km., not much above the lapse rate which is the accepted convention for determining the tropopause height. This is based on a fall of 2°C. in a complete kilometre, which was not observed on the Paris sounding above 13,520 ft. Since there must be a convention of this type in order to fix the height of the tropopause, it is obvious that the tropopause is not on all occasions a well defined physical entity.

The relative humidities reported from Brussels are not included as they appear to be too high, being over 100 per cent. up to the inversion and over 80 per cent. up to the tropopause. The Paris ascent was considerably drier and the morning ascent at Utrecht (de Bilt) showed similar humidities to those at Paris. Its temperature distribution was rather like that at Brussels, but there was a lapse of 9°F. from 560 mb. to the tropopause at 500 mb. The weather was mainly fine on the Continent, but there was local snow in which saturation was probable from the cloud base to the top of the very cold air.

The second curve in Fig. 1(a) illustrates the rapid change of structure over Brussels in 12 hours. The other curve in Fig. 1(b) shows the temperature and humidity at 0800 over Downham Market, when temperature was at its lowest. The temperature of -14°F. at 700 mb. was 29°F. below normal and one of the

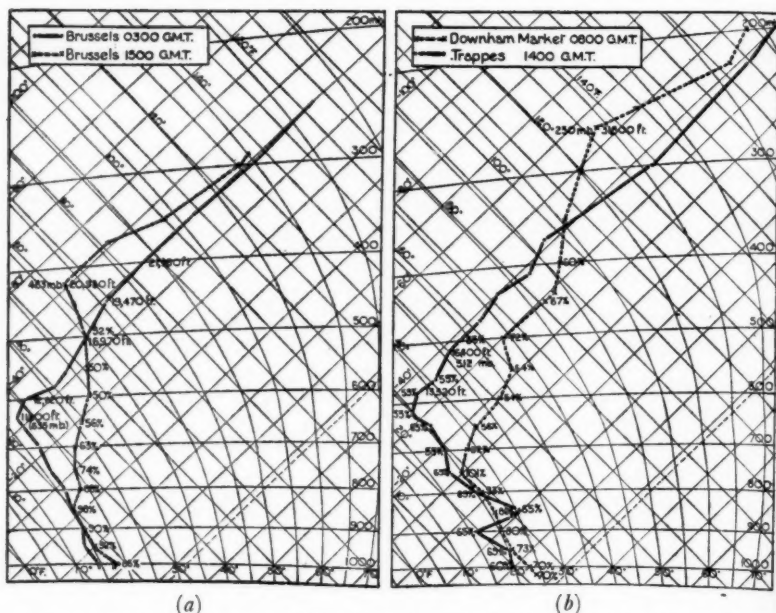


FIG. 1—TEPHIGRAMS OF RADIO-SONDE ASCENTS ON FEBRUARY 20, 1948
Relative humidities are written at the side of each ascent.

lowest ever recorded at that pressure in the British Isles, though it was 8°F. higher than at Brussels at 0300. The tropopause was as high as 31,800 ft.

It is impossible to give any adequate explanation of the abnormal atmospheric structure. On the previous day the tropopause over and to eastward of the area was at about 300 mb., and the associated potential temperature was about 30°F. above that at 500 mb. on February 20 in the continental region we are considering. This shows that the whole thick stable layer, including what was technically the upper troposphere and lower stratosphere, was developed between the 19th and 20th, by a combination of factors, out of the rather stable middle and upper tropospheric air of the 19th. Much more detailed information as to wind, temperature, and humidity over the area would be required in order to elucidate the problem.

Fig. 2 shows the distribution of sea-level pressure at 0600, and also the thickness contours of the height of the 500-mb. surface above the 1000-mb. surface at 0300, which is proportional to the mean temperature of the layer between those surfaces. These indicate a cold pool centred very near Brussels, with an extension to central Europe. The cold pool was formed out of a cold tongue which had previously extended south-south-west across Russia from the White Sea and then west-south-west round the boundary of the anticyclone to northward. The cold pool became detached from its parent cold tongue and moved west-south-west, finally reaching the Bay of Biscay in a weakened condition on the 22nd.

This period was remarkable for the amount of dry snow which fell in south-east England, including the London area. In about 48 hours, beginning on the

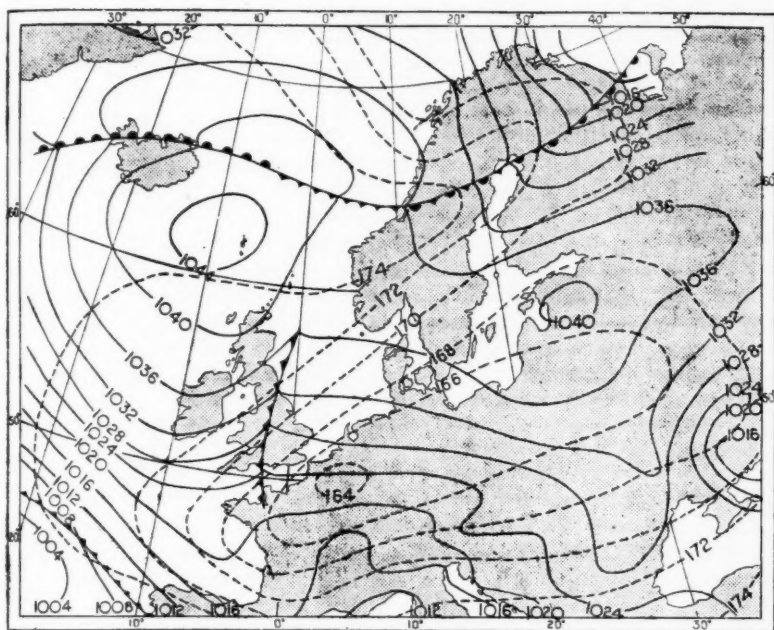


FIG. 2—SYNOPTIC CHART, FEBRUARY 20, 1948

Sea-level isobars (full lines) and fronts are at 0600 G.M.T.; 1000 to 500-mb. thickness lines (pecked lines) are at 0300 G.M.T.

morning of February 20, 10 in. fell over much of Kent, Sussex, and Surrey, and Biggin Hill had 14 in. Appreciable falls also occurred in south-west England, including the Scilly Isles. The snowfalls developed within a continental air mass with a comparatively short sea track, and were much the heaviest falls of this character within recent decades. The snow was of instability type but it sometimes lasted for hours, associated with minor troughs of low pressure moving westward, and a general slow fall of pressure. It is well known that moving cold pools are liable to produce these effects, but the process is not fully understood. On February 20 there were large cumulus clouds over land with a surface temperature of about 24°F.

The upper wind structure over England on that day was of considerable interest. Since the cold air came from the north-east it might be thought at first sight that in the layer where the lapse rate decreased the NE. wind would also decrease with height. Actually the presence of a warm anticyclone to northward indicated that the opposite structure was more likely, and this was in fact observed. The 0900 observations at Downham Market, corresponding to the temperatures shown in Fig. 2, were as follows:—

Pressure			Wind			Pressure			Wind		
mb.	°true	kt.	mb.	°true	kt.	mb.	°true	kt.	mb.	°true	kt.
900	070	36	500	060	91						
800	050	48	400	060	135						
700	050	45	300	060	144						
600	060	65									

The air at 500 and 300 mb. can be traced back round the warm anticyclone to the region south-west of Iceland. At 500 mb. it had spent three days in the area north of 65°N. , but it was over water till it reached north-west Russia. On the other hand, the very cold air lower down moved more slowly, and had reached north-west Russia from the permanent cold pool over the Arctic. The rather low relative humidity indicates that the air in the stable middle troposphere had probably subsided to some extent, but this was much more likely to have occurred during February 16 to 19, when the air was coming round the anticyclone, than on the 20th, when there was a slight cyclonic curvature of the isobars at all heights from sea level to 500 mb.

It is often found that when an air current increases upwards, without change of direction, the trajectories of the air at different levels diverge widely after they have been followed backwards or forwards for a day or two. The upper instability often noted in strong SE.-SW. upper currents on a cyclonic trajectory is the reverse of the upper stability in a case like this, which is liable to occur with a wind from any northerly point increasing upwards.

VARIATIONS OF TEMPERATURE IN A FREE WATER SURFACE

BY K. STORMONTH, B.SC.

Introduction.—The evaporimeter tank in service at Rye is of $\frac{1}{8}$ -in. galvanised iron, measuring 6 ft. by 6 ft. and is 2 ft. deep. It is sunk in the ground for 1 ft. 10 in., a 2-in. flange, 0.4 in. thick, which runs outside the top of the tank, being exposed above the ground surface. The actual depth of the water varies of course, but to maintain a fair consistency of exposure this depth is kept as far as possible between 1 ft. $7\frac{1}{2}$ in. and 1 ft. 9 in. Still-water chambers, approximately 1 ft. square, are attached to two top corners of the tank for float and hook gauges respectively. The tops of these are level with the top edges of the tank proper.

Two sets of observations have been made, one in December 1946 and January 1947, the other in August 1947. The following aspects of variation were investigated:—

- (1) Diurnal variation of temperature at a fixed point in the surface.
- (2) Variation of temperature with depth below the surface.
- (3) Horizontal variation of temperature in the surface.

Days of considerable solar radiation were selected as the variations were expected to be more considerable on such occasions. In the attached tables will be seen any available corresponding air and earth temperatures, sunshine durations, wind speeds at 4 ft. above ground and amounts of evaporation.

Method of observation.—Thermometers of the type used in Assmann psychrometers were used, the upper part of the stem being held in the hand and a reading being taken after very careful immersion so as not to disturb the temperature profile of the surface water. The possibility of radiation effects upon the thermometers was not overlooked, and whenever readings were being made care was taken to shield the thermometer bulb with the observer's body. The thermometer stems were calibrated for length, and measurements were taken from the mid points of the bulbs, which are themselves 0.65 in. long. It

should be pointed out that the temperature gradients reported between depths of 1 in. and 2 in. should be accepted with reserve as it was most difficult to hold the thermometers in position long enough for an accurate reading at the same time maintaining a fixed depth to within a fraction of an inch.

Not on all occasions but whenever possible two observers took independent sets of readings.

Diurnal variations.—Readings were taken at a depth of 2 in. below the surface at a point 2-2½ ft. from the south-south-west wall of the tank. It is seen that the daily temperature range between sunrise and sunset in summer is approximately 4-5 times that experienced in winter. In summer, observations were taken on seven August days with considerable sunshine, and the mean hourly values have been plotted in Fig. 1(a). For winter, five sunny days in December and January have been similarly treated. Mean values at a depth of 10 in. have also been drawn for August, but there was insufficient vertical gradient in winter to permit of similar action. In summer, the maximum temperature at 2 in. deep would appear to be attained between 1500 and 1600 G.M.T., whilst the maximum at 10 in. is not reached until about an hour later, these approximate times being confirmed by separate and intermediate readings. In winter, the 2-in. maximum temperature is attained earlier at about 1300-1400, this also being confirmed by individual tests. Winter values are shown in Fig. 1(b).

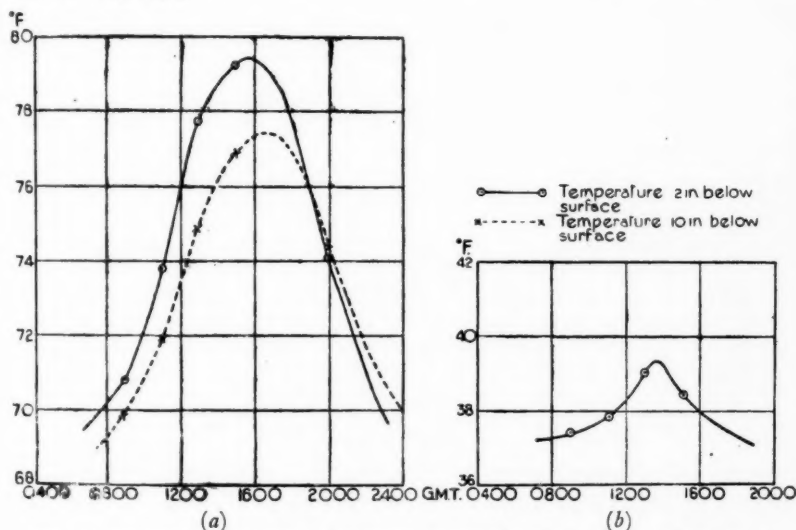


FIG. 1—DIURNAL VARIATION OF WATER TEMPERATURE AT A POINT 2-2½ FT. FROM NEAREST WALL OF TANK

(a) 7 sunny days, August 1947, (b) 5 sunny days, December 1946-January 1947.

Variation of temperature with depth below surface.—Readings were taken at a point 2-2½ ft. from the side of the tank at depths of 1, 2, 3 and 10 in. below the surface. Fig. 2 illustrates the summer results. Studying this figure and Fig. 1(a) the greatest overall decrease of temperature with depth is seen to occur some time between 1300 and 1400 G.M.T., whilst by 2000, a reverse

TABLE I—MEANS FOR DAYS OF CONSIDERABLE SUNSHINE

TIME	WATER TEMPERATURE			AIR TEMPERATURE			EARTH TEMPERATURE			SUNSHINE	WIND 4 FT.	EVAPORATION								
G.M.T.	1 in. deep at dis- tances from south- west side 1 in. 1 ft. 2½ ft.	2-2½ ft. from side at depths of 1 in. 2 in. 3 in. 10 in.		Dry Wet Max. Min.			1 in. 2 in. 4 in. 8 in. 1 ft. 4 ft.			hr.	m.p.h.	in.								
AUGUST 1947, 7 days																				
0900	72.0	71.8	71.1	71.0	70.8	70.2	69.8	74.5	67.8	82.6	57.3	71.7	68.7	65.8	66.4	60.1	12.2	5.4	(a) 0.123	
1100	75.1	74.9	74.4	74.5	73.8	73.4	71.9	79.3	69.8	—	—	78.8	73.8	68.4	66.7	—	—	5.4	(b) 0.026	
1300	79.0	78.7	78.4	78.3	77.7	76.9	74.9	81.7	69.3	—	—	83.5	78.7	71.2	67.8	67.2	—	6.2	(b) 0.026	
1500	79.4	79.2	79.0	79.1	79.2	78.7	76.9	81.2	68.4	—	—	82.9	80.3	73.2	68.7	67.8	—	5.6	(b) 0.026	
2000	73.9	74.1	74.0	73.9	74.1	74.3	74.4	62.8	60.5	—	—	68.8	70.1	71.1	69.6	68.0	—	1.3	(b) 0.026	
DECEMBER 1946 to JANUARY 1947, 5 days																				
0900	—	—	—	—	37.4	—	—	32.8	32.1	40.8	29.2	—	—	—	39.8	42.4	48.4	5.2	5.6	(a) 0.012
1100	37.9	37.8	37.8	37.8	37.8	37.9	38.2	36.6	—	—	—	—	—	—	40.0	—	—	—	6.0	(a) 0.012
1300	—	—	—	—	39.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(b) —
1500	—	—	—	—	38.4	—	—	36.9	35.4	—	—	—	—	—	39.8	—	—	—	5.2	(b) —

gradient, i.e. increase of temperature with depth is established to a distance of at least 4-5 in. It will be noticed that the marked decrease of temperature with depth between 1 and 3 in. seen at 1300 has decreased markedly or even vanished by 1500. Even allowing for the difficulties of measuring in the surface mentioned above, this phenomenon can be asserted for August, a special study having been made on this point. In winter, little variation with depth occurs, the average 10-in. reading at 1100 being 0.4°F . higher than that for 1-2 in.

Variation of temperature horizontally.—The south-south-west wall of the tank is subject to solar radiation upon the top two to three inches, and this has an effect upon the temperature of the adjacent water. Holding the bulb at a depth of 1 in. in each case, readings were taken at distances of 1 in., 1 ft. and $2\frac{1}{2}$ ft. from the wall in question. As expected, the effect was more marked in summer. By day water near the wall was warmed, a reverse cooling effect being noticed later in the evening. The effect did not extend beyond a distance of $2\frac{1}{2}$ ft. from the south-south-west wall.

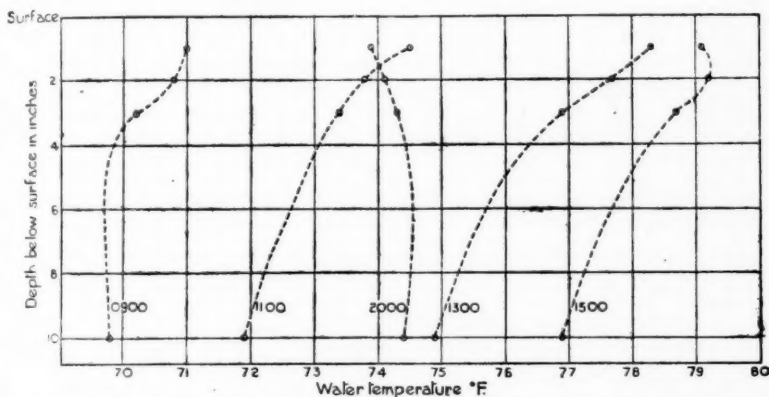


FIG. 2.—VARIATION OF WATER TEMPERATURE WITH DEPTH AT A POINT $2-2\frac{1}{2}$ FT. FROM THE NEAREST WALL OF TANK FOR 7 AUGUST DAYS WITH CONSIDERABLE SUNSHINE

Additional notes regarding data.—Wind readings were taken by means of recording electric cup anemometers, and hourly values noted were mean speeds for periods of 30 minutes centred around the particular times of observation.

Evaporation readings quoted are (a) means for periods of 24 hr. commencing at 0900 G.M.T. and (b) means for periods of 6 hr. also commencing at 0900, on the days of observation.

Readings in column 4 of the tables (i.e. 1 in. deep, $2\frac{1}{2}$ ft. from south-south-west wall) do not agree with corresponding values in column 5 (i.e. distant $2-2\frac{1}{2}$ ft. from side at depth of 1 in.), as they do not necessarily refer to identical readings.

BOOKS RECEIVED

Observations made at the Royal Magnetic and Meteorological Observatory at Batavia, by H. P. Berlage, jr. Vol. LXVI A 1943 Meteorological observations. 4to, 15 in. \times 10 $\frac{1}{2}$ in. pp. vii + 63. Batavia [1948].

THE USE OF BAROGRAPHS IN SHIPS

BY J. R. BIBBY, B.A.

Autographic records from ships' barographs are often unsatisfactory because the pen draws not a line but a "ribbon" several millibars wide. For this reason open-scale barographs are rarely carried on ships, small barographs being normally used. Consequently ships are unable to report barometric tendencies with the high accuracy required for synoptic observations, and which is normally achieved at land stations.

There are four factors which may contribute to the broadening of the trace:—

- (a) Vibration due to the ship's engines, etc.
- (b) Movement of the pen-arm caused by angular accelerations of the ship (rolling and pitching).
- (c) Transient pressure changes caused by gusts of wind.
- (d) Oscillations of pressure due to the rise and fall of the ship.

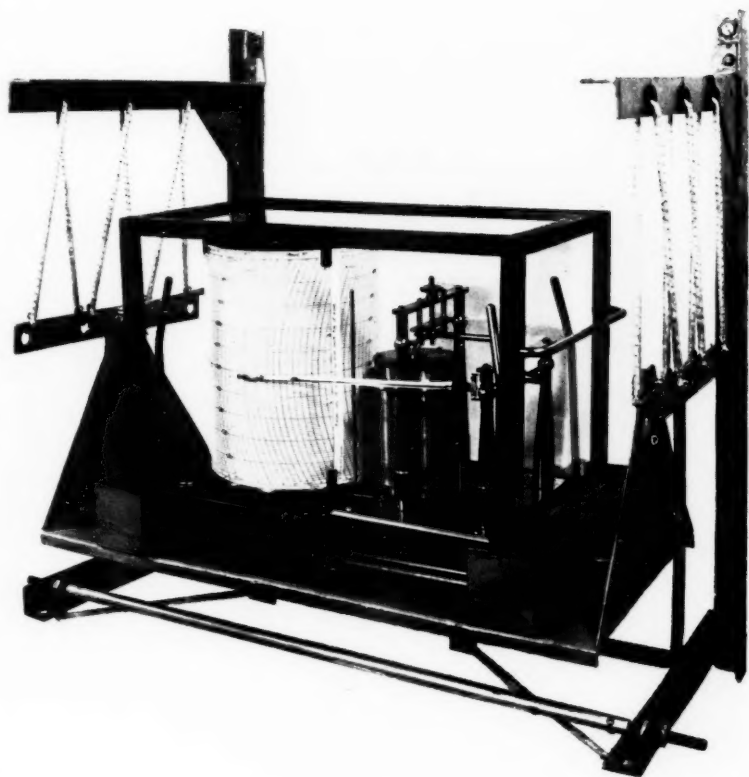
It is difficult to decide the relative magnitudes of these causes as all four usually act simultaneously, but two facts throw light on the question. First, barograms from the largest passenger liners are as a general rule no better than those from smaller craft. This indicates that gusts of wind play a large part in broadening the trace, as the other three factors would probably be much less in the case of a large ship. Secondly, trawlers' barograms often show sudden increases in the width of the trace when the steam winch is started up, showing that, here at least, vibration plays a large part.

It can therefore be concluded that, though different factors are likely to predominate in different types of ship, the chief causes of poor barograph traces are variations of pressure due to gusts of wind, and mechanical vibration. Experiments have recently been completed in the Instruments Branch of the Meteorological Office with the object of obtaining better records from ships' barographs, so enabling open-scale barographs to be used in ships. The experiments fell into two parts, one to reduce the effects of vibration and the other to reduce the effect of transient pressure fluctuations. The results of the experiments are described below.

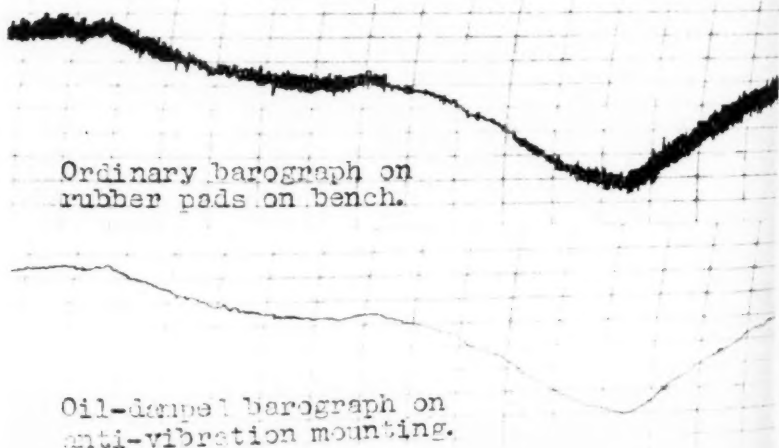
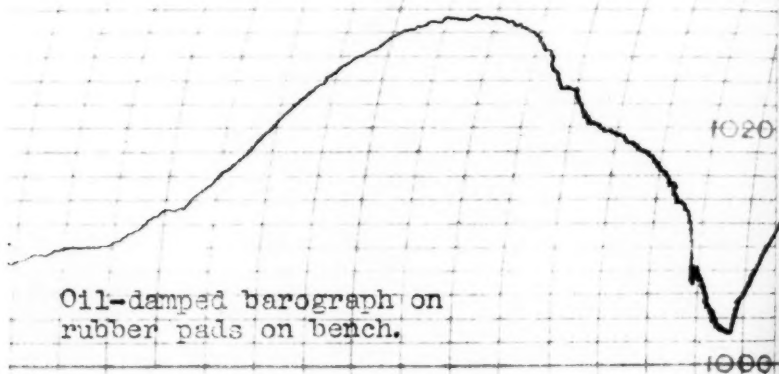
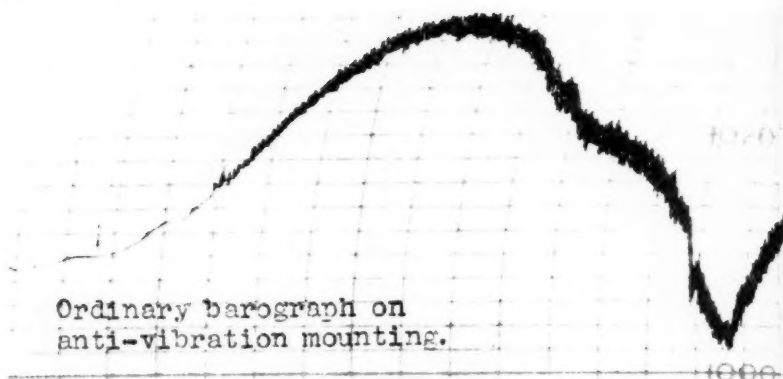
Meteorological Office anti-vibration mounting for open-scale barographs.—This is illustrated in the photograph opposite, and consists of a metal tray to hold the barograph, suspended from fixed brackets by a number of elastic cords. The tray can swivel about an axis parallel to its longer edge, so as to prevent the ship's motion from throwing the pen off the chart.

Maximum freedom from vibration would be obtained by making the supporting elastics very weak, but a fairly stiff support is necessary to prevent excessive movement of the barograph in a rough sea. The present arrangement is thought to be about the best compromise in this respect, the supports being such that the period of oscillation of the shelf (with barograph in position) is about 0.5 sec. Favourable reports have been received from the ocean weather ships, and the only modification contemplated for the future is some elimination of the projecting edges and corners to reduce the risk of accidents.

Oil-damped barographs.—To prevent the barograph recording transient pressure changes it is necessary to introduce a delaying or "damping" factor in its response, as in the case of the marine barometer. The optimum degree



OIL-DAMPED BAROGRAPH ON ANTI-VIBRATION MOUNTING



SPECIMEN BAROGRAMS TRACED ON BOARD THE *Weather Observer*
Upper two barograms from 1600 G.M.T., September 20, to 1600, September 22, 1947;
Lower two barograms from 1900 G.M.T., October 3 to 1900, October 5, 1947. Position of
Weather Observer: Station I, 60° N. 20° W.

of damping requires a compromise between recording accurately large genuine barometric tendencies, but not recording spurious changes of pressure. Three extreme cases were considered, as follows:—

(a) Gusts of wind raise the pressure by 5 mb. for periods of five seconds at a time.

(b) The ship rises and falls over a total amplitude of 25 ft. with a period of 20 sec. The range of pressure variation corresponding to this range of height would normally be about 1 mb., but Sir Geoffrey Taylor has pointed out that this is only true if the velocity of the wind is the same as that of the waves. The pressure variation is doubled if there is no wind, and may be even greater if the wind has a component in the direction opposite to that in which the waves are travelling. Because of this the total amplitude of the pressure oscillation was assumed to be 3 mb.

(c) After falling at the rate of 6 mb./hr. the barometer starts rising at the same rate.

It was assumed in each case that the tendency (change of pressure in three hours) is required with an accuracy of 0.2 mb., and in (a) and (b) this was interpreted as restricting the total width of the trace to 0.4 mb. The required exponential lag coefficients can be calculated from these assumptions, and the minimum values were found to be 60 sec. in case (a) and 23 sec. in case (b). In case (c), if the tendency is required to an accuracy of 0.2 mb. the barograph must clearly not lag behind the actual pressure by more than 0.1 mb., which implies a maximum lag coefficient of 60 sec. (This assumes that the time scale is sufficiently open to allow such a rapid change to be read accurately.)

These figures imply that the lag coefficient should be exactly 60 sec. with no variation allowable. As this was not expected to be practicable the calculations were repeated, allowing errors of 0.4 mb. in the tendency in extreme cases. The permissible lag coefficients were then found to be (a) 29 sec. (minimum), (b) 11 sec. (minimum), (c) 120 sec. (maximum), so allowing a four to one ratio of lag coefficients.

The damping of the barograph movement was effected by the use of a viscous oil. This idea is not new, as a barograph widely used in the United States has vanes attached to the pen-arm spindle moving in oil-filled cylinders. In the present case, however, a different arrangement was used which eliminates any strain on the levers, and also prevents movement of the pen being allowed by looseness in the pivots. As shown in Fig. 1, the barograph bellows is inside a brass cylinder filled with oil, and can only expand or contract by forcing oil to flow through the narrow annular gap where the rod passes through the hole, A, in the top plate. (An enlarged view of the hole, with dimensions, is shown in Fig. 2.) For example, in the case of the Short and Mason open-scale barograph used for these experiments, a change of 1 mb. in the reading causes the passage of about 50 cu. mm. of oil through the annular gap. A brass plug, B, threaded both internally and externally, can be screwed down into the lid of the cylinder, so sealing it and allowing the barograph to be transported already filled.

One difficulty in the use of oil for this purpose is the large variation of viscosity with temperature. Experiment showed that with a fixed size of gap the lag coefficient was roughly proportional to the viscosity of the oil used, so

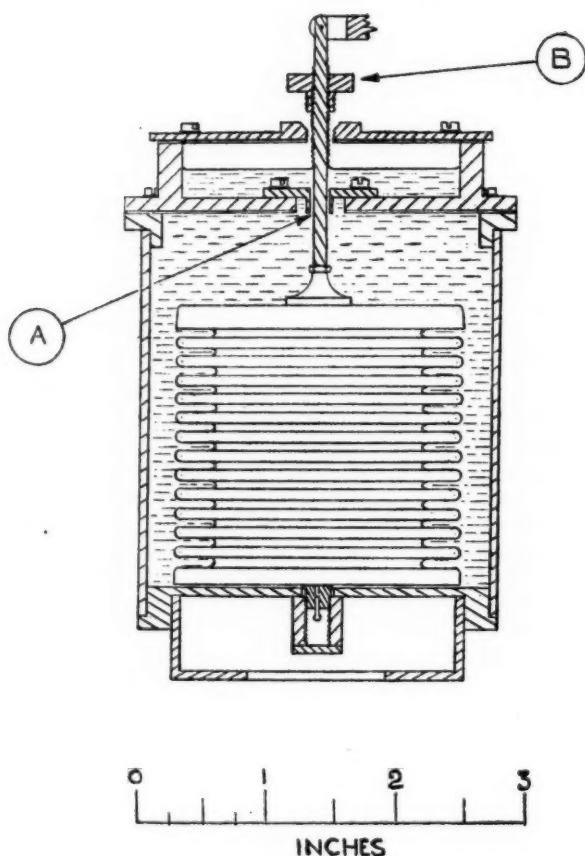


FIG. 1—CROSS-SECTION OF BELLOWS AND OIL CONTAINER

it was necessary to use an oil whose viscosity varied by not more than 4:1 over the range of temperatures likely to be experienced by a barograph in a ship. This was assumed to be 30°F. to 110°F.

The Government Chemist's Department was consulted, and they ascertained that the most favourable hydrocarbon oil had a viscosity variation of 12:1 over the required temperature range. They recommended the use of silicone fluids, which have a much lower temperature coefficient of viscosity. Several samples of different silicone fluids were tested and found to have viscosities varying by a factor of only 2.5:1 over the temperature range 30–110°F. The barograph, as finally made up for trials at sea, had the following lag coefficients:—

100 sec. at 30°F.	70 sec. at 70°F.	40 sec. at 110°F.
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(The corresponding viscosities of the silicone fluid were approximately 100, 70, and 40 gm./cm./sec. respectively.)

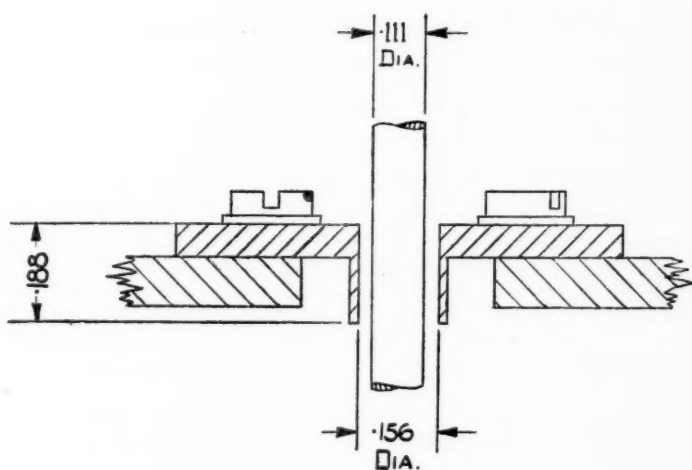


FIG. 2—ENLARGED VIEW OF ANNULAR GAP
(Dimensions are in inches)

Results of trials at sea.—The oil-damped barograph and an ordinary open-scale barograph have been carried in O.W.S. *Weather Observer* since September 1947, during which time much rough weather has been encountered. One barograph stands on the anti-vibration mounting and the other on sponge rubber pads on a bench, the two being interchanged periodically. The chief conclusions to be drawn from the barograms obtained (typical sections of which are shown in the photograph facing p. 177) are as follows:—

(a) The ordinary barograph often gives a trace 2–3 mb. wide, there being no visible improvement when on the anti-vibration mounting.

(b) The oil-damped barograph standing on the bench gives a trace hardly ever wider than 0.5 mb., and never wider than 1 mb.

(c) When the oil-damped barograph is on the anti-vibration mounting it is almost impossible to detect any broadening of the trace, which never exceeds 0.3 mb. This can be regarded as equivalent to a barogram at a sheltered land station.

It is therefore concluded that oil-damped barographs should be adopted for use at sea, and preferably also at land stations, or at least the more exposed ones. The relatively expensive silicone fluids (which cost nearly £1 per barograph) need only be used where wide variations of temperature are encountered, i.e. on voyages covering a big range of latitude. A much cheaper hydrocarbon oil could be used at land stations, and probably also on ships confined to temperate latitudes, including ocean weather ships.

It appears that the anti-vibration mounting should be used at sea when the very best results are required, or in ships especially subject to vibration. But if in any case the use of this mounting would be inconvenient, e.g. for lack of space, an oil-damped barograph standing on sponge rubber pads would give reasonable records.

METEOROLOGICAL RESEARCH COMMITTEE

The second meeting of the Instruments Sub-Committee was held on June 10, 1948. Three papers dealing with upper air observations were considered. One of these (*M.R.P.* No. 406 by Mr. J. K. Bannon) deals with the errors in computed upper winds based upon measurements made with GL Mk. III radar equipment. Another paper (*M.R.P.* No. 405 by Dr. R. Frith and Mr. H. C. Shellard) discusses the speed correction coefficient of the Meteorological Office electrical-resistance thermometer. There is some evidence that this coefficient varies with air density though this is not yet certain. The third paper (*M.R.P.* No. 398 by Mr. O. M. Ashford and Mr. H. J. Ferrer) reviews the development of the Meteorological Office radar reflector Mk. IIB.

The Sub-Committee also discussed the need for producing a relatively cheap radar method of measuring upper winds with, if necessary to secure cheapness, a smaller accuracy than is obtainable by the best of the present methods. Such equipment would be useful in parts of the world where financial or man-power reasons prohibit the use of current Meteorological Office equipment. It was decided to investigate the possibility of designing equipment to meet this need.

Other matters considered by the Sub-Committee included a proposed method of measuring the mean atmospheric transmission between ground level and a specified height, and the need for a special radio-sonde for measuring potential gradient.

The second meeting of the Synoptic and Dynamical Sub-Committee was held at Dunstable on June 24, 1948.

Reports on the methods which are being emphasised in the Forecasting Research Division in the study of medium and short-range changes in synoptic conditions and circulation patterns were considered and the possible use of electronic computing machinery in this connexion was also discussed.

It was decided that a number of tephigrams should be printed showing the saturated adiabats and the humidity mixing-ratio isopleths for condensation to water as well as for sublimation to ice, at subfreezing temperatures. In the former case, the lines will be printed in a distinctive colour. One or more copies of this diagram will be sent to each station; they will not be for general use, but merely to illustrate the differences between thermodynamical processes with respect to supercooled water and ice respectively.

The work on the seasonal variation of upper winds over the world has now been completed (*S.D.T.M.* No. 118, Parts I-VI), and the Sub-Committee heard how the task had been accomplished in the Climatological and Investigations Divisions; the charts and tables will be amended as necessary, as further data become available.

A paper (*M.R.P.* No. 392) on the angular deviation of the wind from the isobars by Mr. J. K. Bannon, was also discussed.

ROYAL METEOROLOGICAL SOCIETY

At the meeting of the Royal Meteorological Society held on June 16, 1948, Dr. G. M. B. Dobson, President, in the Chair, Capt. C. E. N. Frankcom (Superintendent, Marine Division, Meteorological Office) described the operation of ocean weather ships and Mr. J. Paton gave an address on the optical properties of the atmosphere.

Capt. Frankcom outlined the story of the development of the ocean weather ships, which commenced work in August 1947, and gave a full description illustrated by lantern slides of their functions and equipment. It was interesting to learn that in addition to their main work of meteorological observation and navigational assistance to transatlantic aviation they are making observations of marine biology and are to collaborate in seismological research. Capt. Frankcom then referred to the difficult conditions in which work has often to be carried on. On some voyages during the winter the wind had never fallen below force 6. Nevertheless no surface observations had been missed and upper air observations, in spite of the extreme difficulties of launching the balloons in strong winds, had been made in winds up to force 10. On only three occasions had ships left their station and then to land sick men.

Capt. Frankcom concluded by emphasising the close and cordial collaboration which existed on the ships between the navigating, meteorological and signals staffs.

He was followed by Captain Ford, commander of the *Weather Recorder* who, speaking on behalf of the Senior Meteorological Officer of his ship, gave a vivid impression of the difficulties of launching balloons 8 ft. in diameter and of plotting synoptic charts during the winter gales when the ships, though very seaworthy, were known to roll through an angle of 55° .

Mr. Paton's address on the optical properties of the atmosphere was illustrated by beautiful Kodachrome slides. These brought out very vividly the relative darkness of the space between the primary and secondary rainbows, the difference between the blue colour of distant hills and the golden colour of distant clouds, and the twilight arch on the eastern sky due to the earth's shadow. An interesting point, dwelt on at some length by Mr. Paton, was that our estimation of the distance of distant dark objects depends on their blueness caused by scattering by the intervening air and when this is small, as it is in the pure air at great heights, distances are very much underestimated.

In the course of the discussion which followed Dr. Dobson said recent work showed that ice crystals at very low temperatures could form in a cubic shape which would produce a 9° halo. Prof. Sheppard said when in the Arctic he had been much impressed by the extreme profusion of refraction phenomena and asked why they were less frequently seen in Great Britain. Mr. Paton said they were there just the same but were blotted out by the greater glare of the sun. They could be seen by wearing dark glasses. Dr. Ramanathan said he had observed a blue flash in the sun setting over the Indian Ocean in April when there was super-refraction of light rays in the hot dry air blowing off India.

LETTERS TO THE EDITOR

Low-level condensation trails

At 1100 G.M.T. on March 8, a Meteor IV aircraft from Horsham St. Faith, near Norwich, formed non-persistent vapour trails whilst making a high-speed low-level run across the aerodrome. The following account has been compiled with the help of the pilot, F/Lt. R. Baelz, D.F.C., and F/Lt. J. Bowring, Engineer Officer.

The aircraft, whilst flying on a north-easterly heading at 3,000 ft., went into a shallow dive and then flew level across the aerodrome at an estimated height

of 300-400 ft. During the dive the true airspeed increased to 580 m.p.h. and this speed was maintained in level flight.

During the shallow dive nothing unusual was noticed, but whilst in level flight the outer two-thirds of the wings became obscured by white vapour which formed on the upper surface of the wings slightly back from the leading edge. The vapour formation did not persist for any distance behind the wings and was most dense near the wing tips. Although it was the outer portions of the wings which were mainly affected, there was a tendency for vapour to form along the wing right up to the fuselage. The vapour formation gradually ceased as the aircraft went into a climb and the dispersal of the trail was marked by a change in colour from white to blue.

The synoptic situation prevailing over East Anglia at the time was that of a moist south-westerly airstream in an open warm sector to the rear of a warm front which had passed through the area during the early morning. Weather was cloudy with a thin sheet of medium cloud, base above 15,000 ft., which gradually merged into cirrostratus. There was little or no low cloud in the vicinity at the time, although low stratus cloud was rather extensive in other parts of England and patches at 800 ft. were still persisting at 1200 G.M.T. at West Raynham, where temperature was a few degrees lower than at Horsham St. Faith. The 1100 G.M.T. surface temperature and humidity at Horsham St. Faith were estimated to be 55°F. and 80 per cent. (1200 G.M.T. values: 57.0°F. and 76 per cent.). An examination of the Downham Market upper air ascents for 0800 and 1400 G.M.T. gave the probable temperature and humidity at 350 ft. as 54°F. and 80 per cent.

The formation of low-level wing-tip trails by a Meteor IV aircraft, under suitable conditions of temperature and humidity might be expected, as its span loading of about 500 lb./ft. (approximately three times greater than that of a Spitfire) combined with the rectangular form of the wing tips, would cause fairly intense persistent vortices to be shed by the wing tips. However, the formation of vapour trails over the general upper surfaces of the wings is rather unusual, especially in straight and level flight, as the pressure reduction responsible for adiabatic cooling and resultant condensation would be effective only while the air is actually passing over the wing surface and this, in view of the high speeds involved, would correspond to a period of 1/70 sec. only. In addition, when flying at really high speeds the leading edges undergo a considerable rise in temperature and this heating effect should tend to prevent condensation.

Stradishall, March 22, 1948

T. L. HUNT

Is a general term necessary for instruments measuring meteorological elements in the free atmosphere ?

Looking over the literature of aerological measuring techniques, one is struck by the various words given for what we imagine today as a radio-sonde. Below is an anthology of word constructions found in present literature :

English :

Radio-meteorograph
Robot weather observer
Radio balloon
Radio-sound
Radio-sonde

French :

Météorographe émetteur de T.S.F.
Radiométéorographe
Radiotélémetre
Radiosonde

German :

Funkentelegraphisch fernmeldender Registrierballon-Meteorograph
Telemeteorograph
Radiometeorograph
Fernmeldemeteorograph
Wettersonde
Radiosonde

Similar terms can be found in the Italian, Spanish, Dutch, Finnish, etc. languages. Radio-sonde or the corresponding translations have come into use more and more, but nowhere is there given a satisfactory definition of the term. In principle, "radio-sonde" is understood to mean an aerological device transmitting by wireless the most important aerological elements : pressure, temperature and humidity (formerly recorded by meteorographs) from a balloon to a ground-receiving station. The following examples make evident the insufficiency of this definition. Radio-sondes have been constructed which measure only the temperature, the pressure being calculated from the transmitted temperatures and the height of the balloon measured by means of theodolites. And also there are radio-sondes transmitting not only pressure, temperature and humidity but height and thickness of clouds and these may also be used, by new methods, for wind measurement. With the same right we may give the name radio-sonde to an instrument constructed only for wind measurement by radio, since there is no fundamental difference between the meteorological importance of pressure, temperature, humidity and wind. Similarly the passive reflectors used for wind measurement by radar without transmitter below the balloon could be named "radio-sondes", but nobody is willing to do so. Further development may also give us "radio-sondes" transmitting pressure, temperature, humidity and other aerological elements without transmitter but by passive reflectors.

Therefore I suggest the introduction of the word "aerosonde", with the definition "instrument or device to sound the atmosphere". The isolated term is rather unimportant for general use but it can be made into a precise statement by corresponding additions. The method of transmission (mechanical, optical, direct or indirect by wireless means or in a still unknown manner) is of no importance. The word "aerosonde" has been so chosen as to be intelligible in all languages by a literal translation. Special forms of the instrument can be marked by additional terms, e.g. an instrument for the measurement of the standard combination : pressure, temperature and humidity can be named "temp-aerosonde"; a device for wind measurements : "wind-aerosonde", etc. Instruments to measure other meteorological elements may be named in the same way : "turbulence-aerosonde", "insolation-aerosonde", etc.

G. LOESER

(23) *Meppen-Ems, British Zone, Germany, December 11, 1947.*

NOTES AND NEWS

A new kit for climatological inspectors

Inspectors' kits are used by officers of the Meteorological Office when visiting observing stations to carry out an inspection. The existing Mk. IV outfit has frequently been adversely criticised because of its excessive weight, and the possibility of introducing an improved kit was accordingly considered in

January, 1946 before ordering more to meet the needs of the post-war inspection programme. The new outfit is known as the Inspector's Climatological Kit Mk. V.

In the design everything possible was done to keep the weight down to a minimum with the result that the new kit weighs less than 10 lb. as compared with the 13 lb. of the Mk. IV. Consideration was also given to cost and durability. The chief feature of the Mk. V kit is that the wooden box has been replaced by a canvas bag with leather fastening straps attached to a covering flap. An additional leather strap is also provided so that the bag can be slung over the shoulders.

It had been suggested that a leather case would be better than a wooden box, but it was found that the saving in weight would not have been so great as with the canvas bag and the cost would have been much greater. With a leather case, compartments are desirable for holding the various instruments and tools and it is very difficult nowadays to obtain leather goods to a new design especially when the numbers involved are small.

The bag and contents are illustrated in the photograph on the opposite page. The main changes from earlier outfits are as follows:—

(a) The rain-measure is graduated for a rain-gauge with funnel of 5-in. diameter. Two sets of graduations are provided, one reading in inches of rain up to 0.50 in. and one in millimetres of rain up to 10 mm. It is safely housed in a wooden box padded with sponge rubber and with hinged lid secured by two leather straps. The box also has a compartment to carry a bottle of oil.

(b) For checking the diameter of the rim of the rain-gauge callipers in the shape of a rule with a travelling vernier is supplied. Readings to 0.01 in. can be obtained.

(c) A spanner hook consisting of a square bar of tool steel with semi-circular hook to embrace the several adjusting screws of the sunshine recorder is provided.

(d) The sunshine sphere centering gauge is housed in a stout wooden box.

The whole kit is very compact, having dimensions 14 in. \times 9 in. \times 7 in.

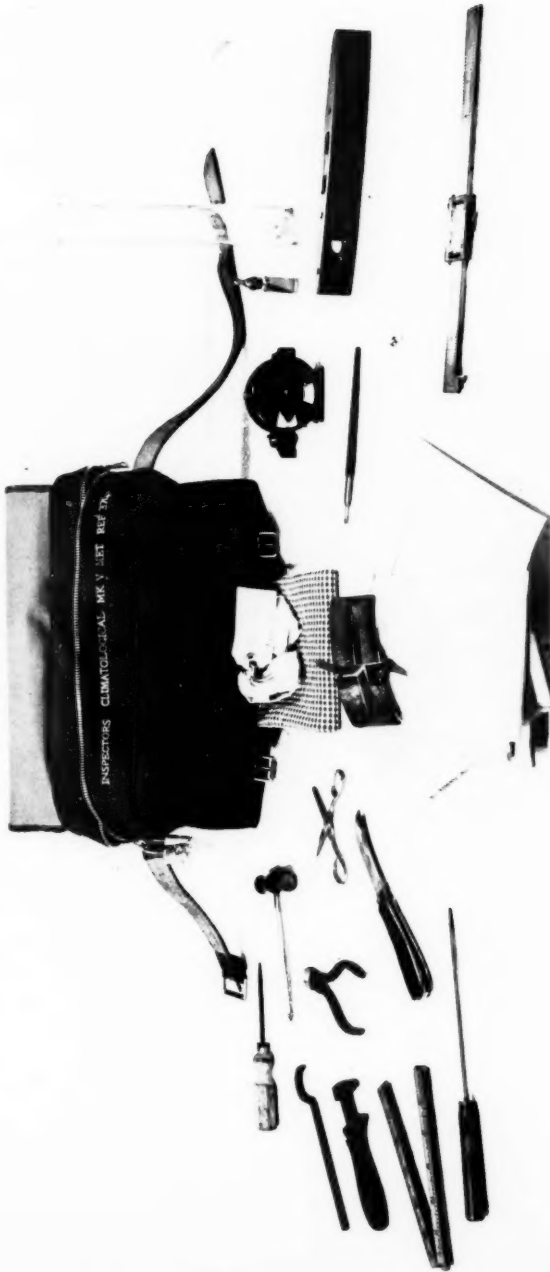
Mk. V kits were first used by inspectors in 1947 and, on the whole, they have proved to be satisfactory. The chief complaint is that all the tools are wrapped up in the duster which is less convenient than having them in separate compartments. It is considered that the saving in weight and cost more than outweigh this disadvantage. Some of the Mk. IV kits are still available for inspectors who prefer to use them.

This work was carried out in the Instruments Branch of the Meteorological Office at Harrow.

H. L. PAGE

Stonyhurst College Observatory

In addition to considerable work in astronomy and geophysics, meteorological records covering a hundred years were completed at Stonyhurst College before Father F. J. Rowland retired at the end of 1947. Founded in 1838 the Observatory has been staffed and maintained by the Society of Jesus, under Directors including Fathers S. J. Perry, A. L. Cortie, E. D. O'Connor and F. J. Rowland. The meteorological results have been published (with the



CLIMATOLOGICAL INSPECTOR'S KIT, MK. V

Canvas bag with straps

Screws, nails, duster,
centering gauge,
publications,
N.P.L. certificate,

Screwdriver, gimlet,
hook spanner, pliers, scissors,
adjustable spanner, clasp knife,
boxwood rule, screwdriver,

Prismatic compass and clinometer,
clock oil, rain measure,
writing diamond, spirit level,
inspector's thermometer,
rain-gauge calipers.

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Photograph by R.A.F.

IMMEDIATELY BEHIND A WEAK WARM FRONT

Cirrostratus and stratocumulus associated with a warm front lying north-north-west to south-south-east over Cumberland; patches of low stratus in the warm air drifting over the Irish Sea. Photograph taken looking south-south-west from 13,000 ft. over 51°30'N., 3°30'W. at 1230, July 30, 1945.

geophysical and solar observations) in annual reports up to that for 1943, as well as in various publications of the Meteorological Office. A summary of the records was included in the *Weekly Weather Report* from 1878 and the *Monthly Weather Report* from 1884.

In 1867 the Meteorological Committee of the Royal Society selected Stonyhurst as one of the seven principal stations, along with Kew, Falmouth, Glasgow, Aberdeen, Armagh and Valentia, each equipped with self-recording instruments of pressure, temperature, wind, sunshine and rain. It is interesting to recall that the object in establishing these seven land stations was "first, to give accurate data for a discussion of the law of storms and weather changes, and secondly, to ascertain meteorological constants, thereby performing with great precision for the land stations that which is accomplished with moderate precision by the Ocean Meteorology Branch for the entire ocean". For many years therefore these stations formed the basis of British meteorology.

The long rainfall record at Stonyhurst has also proved useful with other stations in defining the changes experienced over England during the last century. The temperature record was used by Mr. Gordon Manley in his Presidential address entitled "Temperature Trend in Lancashire, 1753-1945"*, showing the tendency for January and the year to have become on the whole somewhat warmer within the period of the Stonyhurst record.

The continuation of the records during the war was particularly difficult, especially when the observer, Mr. W. Brown, was called to the Forces. In spite of the advancing years and failing health of Father Rowland the records were, however, maintained until his retirement. It is satisfactory to find that Father J. Lawrence is arranging to continue the main records, although observations are being confined to 0900 G.M.T. and some of the instruments are being moved in order to simplify the work.

J. GLASSPOOLE

A new periodical on bioclimatology

We welcome the appearance of the new periodical *Wetter und Leben* (Zeitschrift für Praktische Bioklimatologie), organ of the Austrian Bioclimatological Society. Besides publishing articles it is planned to review all Austrian and as many foreign publications as possible on bioclimatology.

The first number contains articles on the weather of the abnormal year 1947, secular variations in the level of the Danube at Vienna, effects of weather on hay-fever and bioclimatic observations on the pine bark beetle; minor contributions include reports of bioclimatic discussions held at the Zentralanstalt für Meteorologie und Geodynamik, a report on the weather of March 1948 in Austria and nine reviews. It contains 28 octavo pages.

The editor is Dr. F. Sauberer, Wien, XIX., Hohe Warte 38, and the yearly subscription price is given as 24 Swiss francs.

OBITUARY

Professor Filippo Eredia.—With the death of Professor Eredia on February 14, 1948, Italy loses one of her leading meteorologists. Professor Eredia was born at Catania on November 10, 1877. His first scientific post was at the Astrophysical

**Quart. J. R. met. Soc., London, 72, 1946, p. 1.*

Observatory of Catania where he became an assistant in 1903, but in 1904 he transferred to the Central Meteorological Office in Rome. In 1925 he was appointed Geophysical Director of the newly formed Ufficio Presagi of the Ministry of Aeronautics which post he held until 1937. From 1937 to 1945 he was Lecturer in Meteorology at the University of Rome and Director of the Aerological Institute of the University.

Eredia was a prolific worker in many branches of meteorology, the number of separate articles by him in the library of the Meteorological Office amounting to over 200. They include papers on the climatology of many places in Italy and north Africa, summaries and discussions of upper wind and temperature observations, especially those made by the aerological station at Vigna di Valle, climatic effects on the incidence of disease, aviation meteorology, instruments and the teaching of meteorology. In addition to these articles he wrote a treatise on meteorological instruments (two editions, 1916 and 1936), a general text-book of meteorology (1942), and a work on the meteorology and aerology of the North Atlantic Ocean (1935).

Eridia was as well known internationally as in Italy. He became a member of the International Commission for the *Réseau Mondial* in 1919, and later served on the Commissions for Aerology, Climatology, Synoptic Weather and Agricultural Meteorology. He was secretary of the meteorological section of the International Union of Geodesy and Geophysics from 1922 to 1927.

When in 1933 a squadron of Italian seaplanes flew to Chicago and back Eredia was in charge of the meteorological arrangements and provided forecasts for the Atlantic crossings from an office at Londonderry.

He held the Gold Medal of the Italian Society for Climatology and the silver medal of the Italian Geographical Society.

REVIEWS

World Weather Records 1931-40 (continued from volumes 79 and 90), prepared in co-operation with the various official weather services and observatories of the world, assembled and arranged for publication by H. Helm Clayton* and Frances L. Clayton. *Smithson. misc. Coll., Washington, D.C., 105, 1947*, pp. x + 646.

At the International Meteorological Conference held at Utrecht in September 1923 the following resolution was passed :—

“13. The Conference thinks, that publication of long and homogeneous series of observations in the form of monthly means of pressure, temperature and rainfall would be of the highest importance for the study of the general circulation of the atmosphere It proposes that the various meteorological institutes should establish such series up to the year 1920”

To meet the need expressed in this resolution the Smithsonian Institute, with the aid of a generous grant from Mr. John A. Roebling, published in 1927 a book entitled “*World Weather Records*” as volume 79 of their series of *Smithsonian Miscellaneous Collections*. This volume, which was arranged for publication by the late Mr. H. Helm Clayton, contained monthly averages of pressure, temperature and precipitation for 385 land stations. With a few exceptions the tables for each station covered at least the 20 years 1901-20, and for some stations the period covered was much longer. In 1934 the second

* Mr. H. H. Clayton died in October 1946.

volume of "World Weather Records" was published containing the data for 1921-30. The International Meteorological Organization expressed its appreciation of the services rendered by Mr. Clayton and Mr. Roebeling in the production of these two volumes in a resolution passed by the Conference of Directors held at Warsaw in 1935. In 1947 the third volume appeared, giving the data for 1931-40. Meteorology is again indebted to Mr. Roebeling for the funds to publish such a wealth of information in a handy form.

The arrangement follows that of previous volumes. Part I contains the monthly and annual means of pressure, temperature and rainfall at some 420 land stations with the 10-year averages. These tables are preceded, as in the previous volumes, by notes on the stations. On account of the outbreak of war many of the European services (including Great Britain) were unable to co-operate in the preparation of these tables by sending their data. It was possible, however, to extract most of the data for these countries up to 1937, and in some cases to 1939, from official publications which were available in the libraries of Harvard University and Blue Hill Observatory. The British data were copied from the *Monthly Weather Report* and from the "Climatic Table for the British Empire" published for each month in this magazine up to November 1939 which appeared in the number for June 1940.

The data thus collected are not in all cases quite comparable without adjustment with those of the previous volumes. For example, pressure is given at a mean sea level for some stations for which it was previously given at station level. At other stations small differences are introduced by the fact that monthly means have been computed from a different combination of hours from those in the previous volumes.

Among the stations for which pressures are given at mean sea level are Freetown (Sierra Leone) and St. Helena. Unfortunately, on account of incorrect estimates of their heights, the sea-level pressures published for these stations, which were copied from the "Climatic Table for the British Empire", are not correct. The values for Freetown up to July 1935 (when the true height was ascertained) should be corrected by -1.6 mb.; the sea-level pressures for St. Helena require the following corrections: $+2.3$ mb. to August 1933, $+3$ mb. from September 1933 to the end of 1937, -0.7 mb. from January 1938 to May 1939, and $+3$ mb. from June 1939 to the end of 1940.

It is, perhaps, worth while to mention a small point here as it may confuse some users of the tables. In some cases, when the site of a station has changed, the pressure means have been reduced to the level of the old site to keep them consistent with values published in the previous volumes. Where this has been done the old height has been quoted with the result that the published height is not the true height of the station during 1931-40, the period concerned.

Part II which appeared for the first time in the second volume under the title "Ocean and sea-level pressures" is again included. In this volume sea-level pressures are given at the intersections of the parallels and meridians at 10° intervals over the whole northern hemisphere, covering land areas as well as the oceans. For these 289 positions (including the north pole) monthly and annual means are given, with some exceptions, from 1929 to 1939. These means have been published by permission of the Chief of the United States Weather Bureau. They were obtained by reading the pressures at the 10° intersections from the charts published in 1944 by the Weather Bureau entitled "Historical

weather maps, northern hemisphere sea level" which are synoptic charts for approximately 1300 G.M.T. each day. It is considered that, except north of 70°N. and in some areas south of 20°N. where observations are scanty, the pressure means obtained in this way are accurate to about $\frac{1}{2}$ mb. Their agreement with the means for nearby land stations, where observations are as a rule made three or more times a day, is not, however, always quite so close and means for some individual months differ by more than a millibar.

Part III, "Additional data", contains tables of pressure, temperature and rainfall mostly up to 1930, which were received too late for inclusion in the previous volume. Included also in this section are two groups of rainfall tables. In the first group are tables for the banana and sugar areas of the Caribbean Sea, which were supplied by the United Fruit Company of Boston, Mass. These tables do not refer to individual stations but give monthly and annual averages of several stations in each of the areas during the years 1931-40. There is no information about the positions of the individual gauges or as to whether their exposures conform to standard. The second group constitutes a very useful summary of the precipitation in each state or section of the United States during the 55 years 1886-1940: the data are arranged seasonally as percentages of the normal.

Appearing for the first time in this volume is an appendix giving lake and river levels. The lakes included are Victoria, Michigan and Titicaca (Bolivia), and the rivers Nile and Plate. The valuable series for Lake Michigan covers 84 years (1860-1943) of monthly means.

As in the previous volumes, a table of monthly sunspot numbers for the ten years is included.

In all, there are 562 pages of Tables. They are clearly printed on good paper which should be able to stand up to constant use.

E. H. GEAKE

Remarks on some classes of local winds, a contribution to dynamical climatology, by F. H. Schmidt. Koninklijk Nederlandsch Meteorologisch Instituut, De Bilt. No. 125 Mededelingen en Verhandelingen, Serie B, Deel 1, No. 5. Size: $12\frac{1}{4}$ in. \times $8\frac{3}{4}$ in. pp. 10. *Illus.* 's-Gravenhage, 1947. Price 0.75 florins.

This study deals with the classification of a number of well known "local" winds, such as the bora, föhn, etc. Dr. Schmidt's classification is not the customary geographical one. Instead he has put forward a scheme based upon the underlying physical and meteorological conditions which give rise to these winds. He considers that by so doing, these winds can be more easily and logically be identified and appreciated, and a contribution made to the dynamical climatology of the regions where these winds occur. Dr. Schmidt concludes that local winds are due to four main causes:—

- A. To the field of pressure.
- B. To the relief of the earth's surface.
- C. To air mass.
- D. To the passage of a front.

Subsidiary causes give rise to a number of subdivisions. Thus Cause A is subdivided according to (a) the force, (b) the direction and (c) the frequency of the wind, Cause B according as the topography induces the descent of (a) warm, or (b) cold air, or (c) the acceleration of the air in a valley, Cause C accord-

ing as the air mass constituting the wind is (a) arctic, (b) polar, (c) tropical or (d) equatorial, while Cause D is subdivided according as the winds are associated with the passage of (a) a warm or (b) a cold front. Local winds may therefore be ascribed to twelve distinct causes.

As instances of his classification, Dr. Schmidt includes the föhn on the north side of the Alps and on the coasts of Greenland, the autan of central France, the chinook winds of the Rocky Mountains and the zonda on the east side of the Andes under Class B(a); the bora, the bohorok, the local mistral, the bise in the French Alps, the kossava of the Balkans and the polake of Bohemia in Class B(b); the tramontana near Perpignan and the willy-waws at the south point of South America in Class B(c). Examples of the winds of Class C(c) are the sciroco, the khamsin, the brickfielder of Australia and the simoon.

If account be taken of the effect of all the thermal and dynamical influences of the underlying surface on the moving air in contact with it, it is possible to obtain a very large number of classes of air. The author is therefore to be congratulated in steering a middle course between an excessive complexity and over simplification. The inclusion of two classes to take account of local winds at the passage of a front—and the author is unable to find examples of local winds originating at the passage of a warm front—does appear to be a refinement which is not altogether necessary. The text has a number of synoptic charts—a very useful addition to the work.

J. E. BELASCO

NEWS IN BRIEF

A new polar institute (Norske Polarinstitutt) was established in Norway on March 1, 1948, with Dr. H. U. Sverdrup as the first Director.

Continuing and expanding the activity formerly under the control of Norges Svalbard- og Ishavs-undersøkelser, it will provide facilities for numerous scientific workers to visit Svalbard (i.e. all Norwegian polar territory including Spitsbergen, Bear Island, etc.) and east Greenland; it will establish aids for navigation and weather stations. The institute will work under the Department of Industry of the Norwegian Government but will be connected with the Universities of Oslo and Bergen.

Dr. Sverdrup, who has had a distinguished career as arctic explorer, oceanographer and mathematician, has written many books and papers on oceanography including "Oceanography for meteorologists".

WEATHER OF JUNE 1948

During most of the month unsettled conditions prevailed, with depressions or troughs of low pressure crossing the British Isles. There was, however, an interval from the 9th to the 13th during which a wedge of relatively high pressure extended southwards over these islands from an Arctic anticyclone, and another such interval from the 23rd to the 27th when there was a ridge of relatively high pressure connecting anticyclones centred north and south-west of the British Isles.

Mean pressure for the month was below 1010 mb. in Labrador, to the south of Iceland and from the Gulf of Bothnia to the north-west shore of the Black Sea, and above 1020 mb. from the southern part of the Bay of Biscay nearly to Bermuda. It was rather above the average in south-west Europe and the Azores, and over the Greenland sea but below the average from the eastern part of the United States across the British Isles to Russia, the deficiency being about 5 mb. in north-eastern Britain.

The weather over the British Isles was unsettled, wet, dull and rather cool.

Unsettled weather prevailed during the first eight days with depressions or troughs of low pressure passing over the British Isles. Rain, heavy at times, occurred frequently and gales were reported locally on the 2nd, 3rd and 5th and more generally on the 6th. Thunderstorms occurred at numerous places in England on the 1st and in Scotland on the 8th. Subsequently a wedge of high pressure moved slowly east over the British Isles and a spell of less unsettled weather prevailed over much of the country until the 13th. On that day pressure was almost uniform and conditions on the 13th and 14th were warm and thundery with temperature rising to about 80°F. at a number of places. Thereafter the weather again became unsettled and cool, with frequent rain and thunderstorms. During the 23rd the Azores anticyclone spread north-east and a spell of fairer weather occurred in eastern districts from the 24th to 26th. In the closing days pressure was low over southern Scandinavia and high to the west of the British Isles; cool, showery weather occurred and rather widespread thunderstorms were reported on the 28th.

Mean temperature was about average or somewhat below. Warm days occurred on the 8th, 13th, 14th and 26th. The coolest spells were the 1st-6th and 27th-30th. On the whole rainfall was very excessive; less than the average occurred, however, in the extreme north-west of Scotland and over fairly large areas in the south of England. More than twice the average occurred over much of the country extending south from the Moray Firth to north Lancashire and east over the North and East Ridings of Yorkshire as well as in west Wales. More than three times the average occurred in the neighbourhood of Balmoral and Keswick. Among the larger falls in 24 hours were 3.00 in. at Borrowdale on the 2nd and 2.52 in. at Borrowdale and 2.48 in. at Treherbert (Glamorgan) on the 6th. During a severe thunderstorm in the London area on the 14th, 2.41 in. was measured at East Ham. Sunshine was appreciably below the average.

The general character of the weather is shown by the following table:—

	AIR TEMPERATURE			RAINFALL		SUNSHINE	
	High- est	Low- est	Difference from average daily mean	Per- centage of average	No. of days difference from average	Per- centage of average	Per- centage of possible duration
England and Wales ..	°F. 83	°F. 36	°F. -0.4	% 151	+6	% 82	% 33
Scotland ..	79	31	0.0	181	+4	77	27
Northern Ireland ..	74	36	-0.5	139	+4	79	27

RAINFALL OF JUNE 1948

Great Britain and Northern Ireland

County	Station	In.	Per cent of Av.	County	Station	In.	Per cent of Av.
London	Camden Square ..	2.11	104	Glam.	Cardiff, Penylan ..	3.59	143
Kent	Folkestone, Cherry Gdns.	1.89	95	Pemb.	St. Ann's Head ..	3.03	145
"	Edenbridge, Falconhurst	3.42	155	Card.	Aberystwyth ..	5.39	220
Sussex	Compton, Compton Ho.	3.17	127	Radnor	Bir. W. W., Tyrmynydd	5.84	179
"	Worthing, Beach Ho. Pk.	1.42	81	Mont.	Lake Vyrnwy ..	8.13	250
Hants.	Ventnor, Roy. Nat. Hos.	1.27	69	Mer.	Blaenau Festiniog ..	13.89	214
"	Bournemouth ..	2.36	117	Carn.	Llandudno ..	3.30	174
"	Sherborne St. John ..	2.20	103	Angl.	Llanerchymedd ..	3.46	146
Herts.	Royston, Therfield Rec.	3.68	164	I. Man.	Douglas, Boro' Cem. ..	5.82	240
Bucks.	Slough, Upton ..	2.48	120	Wigtown	Port William, Monreith	4.19	178
Oxford	Oxford, Radcliffe ..	2.11	94	Dumf.	Dumfries, Crichton R.I.	6.00	237
N'hant.	Wellingboro', Swanspool	2.99	142	"	Eskdalemuir Obsy. ..	6.93	220
Essex	Shoeburyness ..	1.64	93	Roxb.	Kelso, Floors ..	4.39	208
Suffolk	Campsea Ashe, High Ho.	3.15	167	Peebles.	Stobo Castle ..	4.90	209
"	Lowestoft Sec. School ..	3.40	188	Berwick	Marchmont House ..	3.57	155
"	Bury St. Ed., Westley H.	2.66	127	E. Loth.	North Berwick Res. ..	2.47	149
Norfolk	Sandringham Ho. Gdns.	3.11	143	Midl'n.	Edinburgh, Blackf'd. H.	4.02	201
Wilts.	Bishops Cannings ..	2.31	95	Lanark	Hamilton W. W., T'nhill	5.90	268
Dorset	Creech Grange ..	2.76	120	Ayr	Colmonell, Knockdolian	4.15	164
"	Beaminster, East St. ..	1.83	81	"	Glen Afton, Ayr San. ..	6.32	211
Devon	Teignmouth, Den Gdns.	1.67	87	Bute	Rothsay, Ardenraig ..	5.16	168
"	Cullompton ..	2.61	123	Argyll	L. Sunart, Glenborrodale	5.15	160
"	Barnstaple, N. Dev. Ath.	1.88	84	"	Poltalloch ..	3.87	127
"	Okehampton, Uplands	2.57	93	"	Inveraray Castle ..	7.32	185
Cornwall	Bude School House ..	2.71	135	"	Islay, Eallabus ..	3.34	128
"	Penzance, Morrab Gdns.	2.37	107	"	Tiree ..	3.78	148
"	St. Austell, Trevarna ..	2.40	92	Kinross	Loch Leven Sluice ..	4.93	225
"	Scilly, Tresco Abbey ..	1.70	98	Fife	Leuchars Airfield ..	3.44	206
Glos.	Cirencester ..	2.68	112	Perth	Loch Dhù ..	6.30	151
Salop	Church Stretton ..	3.08	121	"	Crieff, Strathearn Hyd.	4.80	182
"	Cheswardine Hall ..	4.11	168	"	Blair Castle Gardens ..	3.79	228
Staffs.	Leek, Wall Grange P.S.	4.69	180	Angus	Montrose, Sunnyside ..	5.34	214
Worcs.	Malvern, Free Library	3.69	159	Aberd.	Balmoral Castle Gdns. ..	5.07	271
Warwick	Birmingham, Edgbaston	2.25	104	"	Dyce, Craibstone ..	5.22	249
Leics.	Thornton Reservoir ..	3.48	191	Moray	Fyvie Castle ..	4.88	239
Lincs.	Boston, Skirbeck ..	2.56	113	Nairn	Gordon Castle ..	4.03	228
"	Skegness, Marine Gdns.	3.06	139	Inv's	Nairn, Achareidh ..	4.86	219
Notts.	Mansfield, Carr Bank	4.42	167	"	Loch Ness, Foyers ..	7.29	148
Ches.	Bidston Observatory ..	6.87	224	"	Glenquoich ..	5.53	156
Lancs.	Manchester, Whit. Park	4.48	205	R. & C.	Fort William, Teviot ..	3.66	141
"	Stonyhurst College ..	2.44	113	"	Skye, Duntuilum ..	2.24	98
"	Blackpool ..	4.69	228	"	Ullapool ..	4.69	164
Yorks.	Wakefield, Clarence Pk.	5.58	255	"	Applecross Gardens ..	5.64	150
"	Hull, Pearson Park ..	3.61	174	Suth.	Achnashellach ..	2.16	98
"	Felixkirk, Mt. St. John	3.75	204	"	Stornoway Airfield ..	3.19	153
"	York Museum ..	4.80	254	Caith.	Laig ..	3.45	93
"	Scarborough ..	4.08	173	Shet.	Loch More, Achfary ..	2.87	159
"	Middlesbrough ..	3.18	151	Ferm.	Wick Airfield ..	1.90	106
Nor'd	Baldersdale, Hury Res.	4.33	188	Armagh	Lerwick Observatory ..	3.96	146
"	Newcastle, Leazes Pk.	3.77	182	Down	Crom Castle ..	4.33	172
"	Bellingham, High Green	4.81	178	Antrim	Armagh Observatory ..	2.86	104
"	Lilburn, Tower Gdns. ..	9.12	313	Lon.	Seaforde ..	3.42	142
Cumb.	Geltsdale ..	5.33	204	Tyrone	Aldergrove Airfield ..	4.26	146
"	Keswick, High Hill ..	3.50	143	"	Ballymena, Harryville ..	3.78	149
"	Ravenglass, The Grove	7.36	195	"	Garvagh, Moneydig ..	3.78	134
Mon.	Abergavenny, Larchfield			"	Londonderry, Creggan	3.41	121
Glam.	Ystalyfera, Wern House				Omagh, Edenfel ..		

CLIMATOLOGICAL TABLE FOR THE BRITISH COMMONWEALTH, FEBRUARY 1948

STATIONS	PRESSURE			TEMPERATURES						REL- ATIVE HUMIDITY	PRECIPITATION		BRIGHT SUNSHINE		
	Mean of day M.S.L.	Diff. from normal		Absolute		Mean values					Total	Diff. from normal	Days	Daily mean	Per- centage of possible
		Max.	Min.	Max.	Min.	1 Max. 2 Min.	Diff. from normal	Wet bulb							
									°F.						
London, Kew Observatory	1021.8	mb.	°F.	°F.	°F.	°F.	°F.	°F.	%	tenths	in.	in.	hr.	%	
Gibraltar	1020.3	+6.8	58	23	46.0	36.7	41.3	38.0	79	.79	1.43	—	2.4	24	
St Helena	1017.3	+1.2	73	43	65.1	54.3	59.7	55.3	85	6.2	2.58	—	5.8	54	
Pretoria, Sierra Leone	1010.7	+1.4	80	60	83.1	62.1	68.3	74.3	68	3.3	3.30	+1.16	6.6	61	
Lagos, Nigeria	1010.5	+0.8	92	74	85.1	75.7	80.4	75.3	81	5.2	0.00	-0.30	7.3	63	
Kaduna, Nigeria	1009.9	—	98	55	90.4	71.1	80.7	75.9	85	6.8	2.84	—	6.5	55	
Chileka, Nyasaland ..	1013.4	+1.4	88	65	91.2	62.3	76.7	69.4	19	2.3	0.00	-0.02	9.3	79	
Luaka, Rhodesia ..	1011.6	+1.3	86	60	79.1	62.7	70.9	65.0	84	7.7	11.92	+3.84	4.6	37	
Satisbury, Rhodesia ..	1012.6	+1.4	83	55	78.1	60.5	69.3	64.0	74	6.5	5.48	-0.32	18	48	
Cape Town	1013.9	+0.5	102	55	82.1	62.5	72.3	59.8	64	3.9	0.13	-0.45	5	—	
Germiston, South Africa	1013.5	—	83	45	75.5	56.0	65.7	57.3	75	4.1	1.84	—	8.1	63	
Mauritius	1012.2	+1.4	95	65	89.8	71.8	80.8	73.6	76	3.7	2.65	-4.86	10.0	78	
Calcutta, Alipore Obay.	1013.3	-0.2	94	53	84.5	63.0	73.7	67.1	85	3.1	1.47	+0.48	8.6	75	
Bombay	1012.3	-0.4	91	64	84.9	69.9	77.4	64.0	77	1.4	0.00	-0.03	9.6	84	
Madras	1012.7	-0.2	94	67	88.1	71.3	79.7	72.7	86	2.8	0.03	-0.27	10.4	89	
Colombo, Ceylon ..	1011.9	+1.1	91	69	87.6	73.7	80.1	72.5	83	4.8	0.11	-1.77	9.2	77	
Singapore	1010.6	+0.4	91	72	86.1	75.7	79.9	75.3	87	7.8	5.77	-0.85	18	—	
Hongkong	1018.4	-0.2	76	46	67.4	58.4	62.9	59.8	87	6.4	0.17	-1.66	3.0	26	
Sydney, N.S.W.	1013.2	-0.7	94	59	79.3	67.3	73.3	68.4	72	6.4	2.86	-1.40	6.8	50	
Melbourne	1011.7	-2.8	104	53	79.9	59.2	69.5	60.5	58	6.4	1.95	+0.24	7.0	52	
Adelaide	1013.1	-1.2	106	51	82.3	60.9	71.6	59.4	42	5.5	0.22	-0.50	4	74	
Perth, W. Australia ..	1011.6	-1.4	107	58	87.5	65.5	76.5	65.6	50	2.4	0.02	-0.43	10.4	79	
Coalgardie	1012.8	+0.4	101	50	87.6	64.2	75.9	69.9	52	4.6	9.33	+8.48	6	—	
Brisbane	1014.0	+1.5	91	65	83.1	68.8	75.9	70.1	74	6.5	3.30	-3.04	13	56	
Hobart, Tasmania	1016.2	+0.4	79	47	69.8	54.7	62.3	57.9	74	7.7	2.51	+0.63	8	39	
Wellington, N.Z.	1005.8	-1.9	86	68	83.3	74.0	76.7	75.1	74	7.6	32.76	+2.04	21	42	
Suva, Fiji	1007.6	-0.6	89	73	85.3	74.9	80.7	77.4	85	9.2	22.37	+7.43	5.3	38	
Kingston, Jamaica	1016.0	+0.7	92	63	88.9	68.9	76.9	70.7	66	1.6	0.00	-0.60	9.3	86	
Grenada, W. Indies ..	1013.8	+0.3	85	61	83.6	72.9	78.3	72.6	78	5.6	1.34	-1.44	13	—	
Toronto	1023.7	+5.7	52	-30	30.5	15.8	23.1	19.8	—	6.4	3.16	+0.78	14	3.9	
Winnipeg	1022.4	+0.6	59	-30	30.5	15.8	23.1	19.8	—	5.6	0.69	-0.05	5	4.7	
St John, N.H.	1021.0	+7.1	45	-15	26.0	5.8	15.9	9.4	—	4.7	3.33	-0.57	13	5.9	
St John, N.H.	1016.8	+0.2	55	-20	43.6	31.9	37.7	34.4	89	7.0	6.61	+3.35	16	3.1	